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IS 13839 (1993): Sponge Iron/DRI Fines/briquettes for Steel Making [MTD 30: Sponge Iron and Smelting Reduction]



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भारतीय मानक

**इस्पात बनाने के लिए स्पंज लोहा/प्रत्यक्ष अपचपित लोहा
(डी. आर. आई.) फाईंस ब्रिकेट — विशिष्ट**

Indian Standard

**SPONGE IRON/DRI FINES/BRIQUETTES FOR
STEEL MAKING — SPECIFICATION**

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by Sponge Iron and Smelting Reduction Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This is one of the new standards on Sponge Iron specifying the use of Sponge Iron/DRI fines/briquettes by cold bonding. It would serve as a guide to manufacturers for convenient use of DRI fines.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off values should be the same as that of the specified value in this standard.

Indian Standard

SPONGE IRON/DRI FINES/BRIQUETTES FOR STEEL MAKING — SPECIFICATION

1 SCOPE

1.1 This standard covers the basic requirements of sponge iron/DRI fines/briquettes for use in steel making in electric arc and induction furnaces and other steel making processes.

1.2 For the purpose of this standard the sponge iron/DRI briquettes mean cold bonded sponge iron/DRI briquettes, made from sponge iron/DRI fines only.

1.3 This specification does not cover Hot Briquetted Iron (HBI).

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	Title
228 (Part 1) : 1972	Methods for chemical analysis of steels : Part 1 Determination of carbon by volumetric method (for carbon > 0.1 percent) (<i>second revision</i>)
1387 : 1993	General requirements for the supply of metallurgical materials (<i>second revision</i>)
1405 : 1982	Methods of sampling iron ores (<i>second revision</i>)
1493 : 1959	Methods of chemical analysis of iron ores
1493 (Part 1) : 1981	Part 1 determination of common constituents (<i>first revision</i>)
10812 : 1992	Classification of sponge iron/direct reduced iron (DRI) for steel making in electric arc furnaces (<i>first revision</i>)
10852 : 1984	Guidelines for storage and transportation of sponge iron/direct reduced iron (DRI)

3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply.

3.1 Sponge Iron/DRI

It is the resulting product (with a metallization degree greater than 82 percent) of solid state. Reduction of iron ores or agglomerates (generally of high grade), the principal constituents of which are as follows.

Metallic iron, residual iron oxides: carbon and impurities such as phosphorus, sulphur: and gangue (principally silica and alumina).

3.2 Total Iron

It is defined as:

$$\text{Fe(T)} = \text{Fe(M)} + \text{Fe(O)}$$

where

Fe(T) = total iron,

Fe(M) = metallic iron, and

Fe(O) = iron from all residual oxides.

3.3 Metallic Iron

It is the aggregate quantity of iron, either free or combined with carbon (as cementite) present in sponge iron.

3.4 Metallization

It is a measure of the conversion of iron oxides into metallic iron (either free, or in combination with carbon as cementite) by removal of oxygen due to the action of the reductant used.

3.5 Degree of Metallization

It is used to describe the efficiency of removal of oxygen from iron oxide during reduction. It is defined as follows:

$$\begin{aligned} &\text{Degree of metallization} \\ &(\text{percent}) = \frac{\text{Mass of metallic iron}}{\text{Mass of total iron}} \times 100 \end{aligned}$$

3.5.1 Equivalent Metallization

Carbon content in sponge iron at a given degree of metallization is important as it has the capacity to remove oxygen from the remaining iron oxides during steel making. Equivalent metallization is degree of metallization + five times the total carbon in sponge iron.

4 SUPPLY OF MATERIAL

General requirements relating to supply of DRI briquettes shall be as laid down in IS 1387 : 1993.

5 MANUFACTURE

The product is made out of sponge iron fines of 0 to 3 mm fraction with suitable binder to hold the particles when molded in a die under requisite pressure at room temperature. The chemical composition of sponge fines required for the briquettes shall conform to the requirement given in Table 1. The green briquettes shall be allowed to cure for 72 h in a small heap to attain requisite strength. The purchaser should clearly state the grade (*see* Table 2) required both in the inquiry and the order.

Table 1 Chemical Composition of Sponge Iron Fines, Percent
(Clause 5)

Size mm	Total Iron	Fe(m)	C	S	P
	Min	Min	Min	Max	Max
0 to 3	90%	81%	0.2%	0.040%	0.060%

NOTES

1 In case the fines are supplied as sponge iron fines, the composition of the fines shall be as given in Table 1.

2 +3 mm fraction shall not exceed 5 percent.

6 GRADE

6.1 This standard covers 2 grades of DRI briquettes: namely Grade 1 and Grade 2 as given in Table 2.

7 CHEMICAL COMPOSITION

7.1 The chemical composition of DRI briquettes conform to the requirement given in Table 2. Except for metallic iron and carbon the chemical analysis of sponge iron including total iron shall be determined either by the methods specified in IS 1493 : 1959 and IS 1493 (Part 1) : 1981 or any other established instrumental/chemical method. In case of dispute the procedure in the latest edition of IS 1493 for chemical analysis shall be the Referee Method.

7.2 Chemical analysis of metallic iron shall be determined by the methods prescribed in 5.2.1 of IS 10812 : 1992. Chemical analysis of carbon shall be done by the method as prescribed in IS 228 (Part 1) : 1972.

Table 2 Chemical Composition of DRI Briquettes (Magnetics)
(Clauses 6 and 7)

Grade	Total Iron	Constituent, Percent				
		Metallic Iron	Metallization	C	S	P
	Min	Min	Min	Min	Max	Max
1	88	80	90	0.20	0.040	0.070
2	85	71	83	0.20	0.040	0.090

8 SHAPE AND SIZE

Typical shape and size of the cold bonded DRI briquettes shall be as given below:

Shape	Size, mm (Typical)	Mass, g (approx)
Pillow	60 × 30 × 20	100

9 DENSITY

The density of the DRI briquette shall be 4 g/c³, Min.

10 SAMPLING

10.1 In case of fines, sampling procedures shall be as per IS 1405 : 1982.

10.2 Representative samples of DRI briquettes shall be drawn for chemical analysis and physical tests as described in Annex A.

11 MARKING

The material shall accompany a test certificate giving the following:

- a) Grade of the material,
- b) Chemical composition,
- c) Size specification,
- d) Manufacture's name, and
- e) Whether cold/bond briquette.

12 STORAGE AND TRANSPORTATION

12.1 During transportation of the DRI briquettes, the breakage of the briquettes shall not be such that the —10 mm fraction is more than 5 percent or otherwise it shall be as agreed upon, mutually.

12.2 DRI needs special care during storage transportation guidelines for which have been laid down in IS 10852 : 1984.

ANNEX A

(Clause 10)

METHOD OF SAMPLING SPONGE IRON BRIQUETTES

A-0 GENERAL

The briquettes are produced batch wise with suitable binders which generally contain undesirable elements like sulphur and phosphorous. The quality of briquette may or may not remain same even if same materials are used. For grading of sponge iron briquettes, it is recommended that representative sample from each batch of finished product be taken as per the quantity specified in A-1.6 at the manufacturing level. Each batch of product shall vary between 0.4 to 1 t, depending on the type of mixer used.

The following sampling methods shall be followed at the manufacturers end as well as at the point of delivery:

- a) Sampling of sponge iron briquette on batch production, and
- b) Sampling of sponge iron briquette at the buyer's destination.

A-1 SAMPLING OF SPONGE IRON BRIQUETTE DURING MANUFACTURE

A-1.1 Lot

All batch of the briquettes manufactured in a day or in a shift shall be mixed together to constitute a lot. One to two pieces of briquettes up to 500 Kg of batch shall be the basis of withdrawal of sample.

A-1.2 The random sample shall include both broken and unbroken briquettes, if broken briquettes are found in the lot. The broken ones be kept separately for determination of tolerance of sized materials in a lot/stack.

A-1.3 Scoop of 5 kg capacity with fork shall be used in sampling.

A-1.4 The height of the stack of sponge briquette shall not be maintained more than one meter.

A-1.5 The sample collected from each batch of sponge iron/DRI briquette shall be mixed together to constitute average sample of the lot/stack.

A-1.6 The quantity of sample from a lot/stack of sponge iron/DRI briquette shall be as given in Table 3.

A-1.7 Half to the sample collected in accordance with A-1.1 shall be sent for cold crushing strength test.

A-1.8 Other half of sample remaining from the composite, shall be crushed to —12 mm size and reduction of sample shall be made by coning and quartering or 2 parts by splitter or as per the procedure till total quantity comes to 300 g.

A-1.9 The final quantity (300 g) of sample obtained after reduction shall be powdered to —150 μ m size in a disc pulverizer with a tolerance limit as stated below:

75 to 150 μ m —	5 percent
—150 μ m —	95 percent
Total	100 percent

A-2 TRUCK SAMPLING AT THE TIME OF LOADING

A-2.1 The truck sampling shall be done during loading into the truck at sellers stock yard.

A-2.2 The sample shall include both broken and unbroken briquettes if broken briquettes are found in the lot. The broken ones be kept separately for determination of tolerance of sized materials in a lot/stack.

A-2.3 Scoop of 5 kg capacity with fork shall be used in sampling.

A-2.4 The height of the stack of sponge briquettes shall not be maintained more than one metre.

Table 3 Quantity of Sample From a Lot Stack of Sponge Iron/DRI Briquette

Sl No.	Quantity of Material in Stack/Lot, tonne	No. of Pieces	Quantity of Sample, g
(1)	(2)	(3)	(4)
1	1 tonne or fraction thereof	15 to 20	150 to 200
2	Above 1 to 5	15 to 100	1 500 to 10 000
3	Above 5 „ 10	75 to 200	7 500 to 20 000
4	Above 10 „ 15	150 to 300	15 000 to 30 000
5	Above 15 „ 20	225 to 400	22 500 to 40 000
6	Above 20 „ 40	300 to 800	30 000 to 80 000

A-2.5 The sample collected from each batch of sponge iron briquette shall be mixed together to constitute average sample of the lot/stack.

A-2.6 The quantity of sample from a lot/stack of sponge briquette shall be specified in A-1.6.

A-2.7 Half of the sample collected in accordance with A-2.1 shall be sent for cold crushing strength test.

A-2.8 Other half of sample remaining from the composite, shall be crushed to —12 mm size and reduction of sample shall be made by conning and quartering or 2 parts by splitter or as per the procedure till total quantity comes to 300 g.

A-2.9 The final quantity (300 g) of sample obtained after reduction shall be powdered to —150 micron size in a disc pulverizer with a tolerance limit as stated below:

75 μ m to 150 μ m	—	5%
—150 μ m	—	95%
Total μ m		100

A-3 TRUCK SAMPLING AT DESTINATION

A-3.1 Sample shall be collected at the time of unloading of sponge iron briquettes by electromagnet.

A-3.2 Each time of unloading by electromagnet the quantity of sample as specified in A-1.6 shall be collected from the place of unloading or from the truck before lifting of materials by electromagnet.

A-3.3 Sample thus collected shall be crushed and powdered in accordance with A-1.8 and A-1.9.

A-3.4 The sample collected from the truck at the time of loading shall confirm to analysis of the sample collected from the same truck at destination.

A-4 CRITERION FOR CONFORMITY

A-4.1 A lot shall be declared as confirming to the requirements of the specification if all the test results are found to be within desired limit.

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